

The Human Use of Caves in Peninsular and Island Southeast Asia: Research Themes



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ISLAND SOUTHEAST ASIA was the scene of some of the first research-oriented cave investigations in archaeology anywhere in the world. In November 1854, Alfred Russel Wallace landed on the island of Borneo, near the present city of Kuching. While collecting biological specimens, he continued to think about the mechanisms of biological evolution. He identified the importance of the island for investigating evolution in general, the evolution of orangutans and other anthropoid apes in particular, and, it was hoped, the origins of humans (Raby 2001; Wallace 1869). The presentations in 1858 of Darwin's and Wallace's theory of evolution by natural selection, in combination with their interests in the scientific potential of caves in Sarawak, and the enthusiasm generated among leading archaeologists in Britain such as Evans, Boyd Dawkins, Lubbock, and Pitt-Rivers, led to a British expedition to Borneo in the 1870s led by A. Hart Everett. The investigators visited the caves at Bau and Niah in 1873 (Everett et al. 1879–1880; Sherratt 2002), but the expedition failed in its search for early human remains. Greater success was eventually achieved by Eugene Dubois, who arrived in Sumatra in December 1887 (Shipman 2001). In his spare time from his medical duties, he likewise searched caves in dense forest for the remains of ancient human fossils. Finding only a few primate remains that he regarded as fairly recent in age, he arranged for himself to be transferred to Java in 1890 in order to examine the site at Wadjack, at which an ancient human skull was found in 1888. Investigations by his team of engineers and forced laborers on the banks of the nearby Solo River, during and after 1890, famously found ancient human remains—Java Man (*Pithecanthropus erectus*; now *Homo erectus*). The recognition of the region as a key location for understanding human evolution was symbolized in 1994 with UNESCO's recognition of Sangiran as a World Heritage Site.

By the early decades of the twentieth century, cave investigations in many parts of Southeast Asia were beginning to yield stone tools, pottery, human and animal remains, and metalwork, but the apparently “straightforward” stratified and deep sequences reported at that time from parts of western Europe were thought to be

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generally absent, the cave infill deposits often being regarded by Western archaeologists as shallow and frequently disturbed (Anderson 1997). The application of artifact typologies based on the concept of type fossils further limited the perceived value of the lithic assemblages recovered from the caves (Reynolds 1993). Observed problems of bioturbation, reworking, guano digging, human burial and rituals, and political unrest and warfare often combined to promote a minimalist view of the cave archaeology of the region. The Niah Caves in Sarawak in northern Borneo and Tabon Cave in Palawan in the southwestern Philippines appeared to be the exceptions that proved the rule: their excavations by (respectively) Tom and Barbara Harrisson (Harrisson 1957, 1958, 1959, 1965, 1970) and Robert Fox (1970) produced deep sequences and cultural successions spanning parts of the Upper Pleistocene and Holocene. Tom Harrisson's large and complex excavations at Niah were also pioneering in that he employed radiocarbon dating to estimate sediment accumulation rates to aid the construction of a chronology for the sequence. On this basis he defined what he saw as a continuous sequence of human activity in the cave from ca. 40,000 B.P. until the middle Holocene, though variable in intensity and character through time. The investigation of Tabon Cave was less intrusive, but also yielded a sequence that began ca. 40,000–45,000 years ago. Today it is recognized that the region has as rich and complex cave archaeology as anywhere in the world.

The thriving nature of contemporary archaeological research on caves and rock shelters in the region was the context of a symposium, "The Human Use of Caves in Southeast Asia," organized by two of us (GB and DG) at the September 2002 meeting in Taipei of the Indo-Pacific Prehistory Association. The stimuli for organizing this symposium were, first, to present in an international forum our initial observations from the renewed investigations in the Niah Caves, and, second, to place this work in the wider geographical and theoretical frameworks provided by current archaeological research on other caves and rock shelters in the surrounding region, what we have termed for convenience Peninsular and Island Southeast Asia (Fig. 1). All of the papers in this volume were presented at the symposium and then rewritten in light of the symposium discussions about underpinning themes and convergences. The first five papers following this introduction deal specifically with Niah (Gilbertson et al.; Stephens et al.; Barton; Krigbaum; Barker), though Paz and Rabett also deal with Niah material in their papers. The non-Niah papers represent in good measure the richness of the comparative framework in contemporary cave archaeology that we sought. The geographical spread is from Thailand to New Guinea, though most of the papers are concerned with Island Southeast Asia, as is of most relevance to our work at Niah. The chronological spread is from the arrival of the first modern humans in the region to the uses and meanings of caves today. The research materials under consideration range from microscopic starch grains to rock art, from guano to bone tools, and from the bone chemistry of ancient populations to the myths and memories of present-day cave-dwellers.

EXCAVATION STRATIGRAPHIES AND CAVE INFILL DEPOSITS

Caves and rock shelters are widely regarded as a potentially important resource for archaeology for a number of reasons. First, they are natural containers, with a

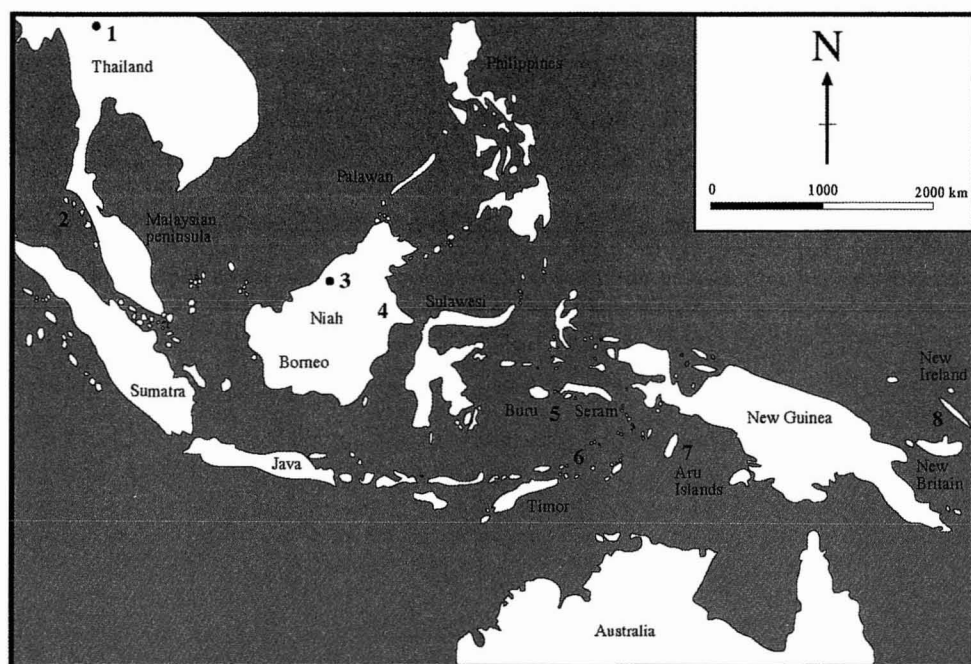


Fig. 1. Peninsular and Island Southeast Asia, showing the locations of the case studies in this volume: 1. Ban Rai rock-shelter, northwestern Thailand (Treerayapiwat); 2. Caves in peninsular Thailand (Anderson); 3. Niah Caves (Barker; Barton; Gilbertson et al.; Krigbaum; Stephens et al.); 4. East Kalimantan (Chazine); 5. Central Maluku (Latinis and Stark); 6. East Timor (Pannell and O'Connor; Veth et al.); 7. Aru Islands (Veth et al.); 8. New Ireland (Leavesley). This volume also includes wider-ranging regional studies by Paz and Rabett.

defined space, so questions about site definition, size, and density may be easier to tackle than in the case of open sites. The interiors of larger caves may have relatively more stable microclimates than the exterior environment and so may have offered more predictable types of shelter from rain, sun, and wind, as well as safety, in contrast with the landscape beyond. As easily identifiable markers in a landscape, sometimes in ecotonal situations at the boundary between different habitats, they tend to attract human activity, and may offer sheltered, defensible, symbolic, or bounded space. Some caves and rock shelters may also be traps likely to collect sequences of deposits that might facilitate the study of the relationships between cultural and environmental changes through time. To achieve these aims, the archaeological evidence excavated from them—be it artifacts, human remains, biological remains, features, or sediments—has also to be interpreted in terms of the site formation processes that brought about their nature, abundance, and distribution at the site, and the complex relationships of these finds with the external world and its events and processes.

Tom Harrisson appears to have regarded the archaeological sites within the Niah Caves and elsewhere that he investigated as essentially the result of a developing “layer cake” of airfall biological materials, with biological and archaeological

materials becoming incorporated, sometimes with subsequent partial mixing. The construction of what appeared to be a sound relationship between radio-carbon dates and depth of material below the surface of a deposit prompted a means of correlation and dating on site that became relatively widespread in Southeast Asia (Anderson 1997). At such excavations, cave infill deposits were often excavated in artificially defined horizontal layers or "spits," cutting through what are now recognized to have been dipping strata. Further biases were caused by the locations selected by excavators for their trenches: a trench in the front part of a cave will have yielded very different cultural material from one at the rear if, for example, prehistoric people made and repaired their stone tools in the former zone and discarded worked-out cores and debris in the latter. The complexity of site formation processes—especially the roles of fluvial processes, subsidence, and mass movement—was clearly demonstrated by Glover (1979) in the case of Indonesian caves, along with the difficulties of trying to arrive at correlations between deposits and artifacts through age-depth relationships. The key roles of complex depositional and taphonomic processes, including mass movement and reworking leading to variations in the character, abundance, and distributions of finds in such caves and rock shelters, are now widely recognized (Anderson 1997).

The interpretation of biological remains found within cave sediments has also advanced notably from the early workers. Take the microfossils of pollen and spores in the Great Cave of Niah as one example: while it is not yet possible to show quantitatively how the airfall pollen component accumulating in a cave entrance reflects the pollen rain that is representative of the vegetation within a kilometer or so of the cave entrance, the relationships between external vegetation and pollen in the droppings of bats and swifts are now increasingly evident (Coles and Gilbertson 1994; Hunt and Rushworth in press). Overall, the taphonomic pathways and processes by which such microfossils enter, are deposited, and are preserved within cave sediments are still poorly known for the region, both qualitatively and quantitatively; they are the consequences of processes such as drip water, human movement, animal fur and paws, scats, whole-organism decay, oxidation, microbiological attack, bioturbation, and so on. Similar taphonomic awareness appropriate to the region is needed to support interpretations of other important palaeoecological indicators of the kind now being recovered from Niah's cave sediments, such as wood charcoal, diatoms, phytoliths, and starch grains (this volume: Barker; Barton; Paz; Stephens et al.). The "signatures" within cave infill sequences of human activities—foraging, cultivation, surface clearance, burning, occupancy, industrial activity, and so on—all need to be established with precision and reliability. Caves and rock shelters can be seen to be complex landscapes in which anthropogenic factors may sometimes play little or no part in the construction and transformation of their contents, or sometimes a major role. In short, the activities of different species, the evolution of deposits, and broader environmental change combine to create complex and challenging deposits that are likely to be poorly suited to excavation using horizontal "spits" (Reynolds 1993). The complex taphonomy, the mix of natural and cultural processes forming and transforming cave archaeology, is exemplified in the ongoing studies of the sequence in the West Mouth of the Great Cave of Niah, which are reported in this volume by Gilbertson et al. and Stephens et al.

THE USE OF CAVES AND ROCK SHELTERS

Tropical rainforest foragers, like desert foragers, tend to rely heavily on plant gathering, because productivity in terrestrial ecosystems increases toward the equator along with the length of the growing season (Lee and Daly 1999). They therefore often practice “residential” foraging, using a series of residential or base camps located to have daily access to favored food sources. People go out from the campsite on a daily basis as individuals or in groups to hunt or gather, the whole group moving from one location to the next (hence the term “residential mobility”) as the resources around a particular campsite start to diminish. For such groups, caves and rock shelters might be residential camps if they are in the right location for the particular food sources being sought. Of course, caves and rock shelters in tropical environments also have an inherent value in offering protection from rain for people and their possessions, but most camps will tend to be elsewhere in the landscape, where the food is.

In attempting to understand the nature of the human use of caves and rock shelters in Southeast Asia, therefore, our starting point cannot be an assumption that the caves and rock shelters had an inherent refuge value, like caves in the Pleistocene cold-stage deserts of northern latitudes, for example. Certainly the archaeological record suggests that many caves in peninsular and island Southeast Asia may have served as significant foci of human activity in the Pleistocene and Holocene, and indeed we can see instances in some periods and locations where environmental and cultural factors seem to have combined to favor sustained occupations (see this volume: Anderson; Barker; Pannell and O’Connor). In many other situations, however, the likelihood is that most cave occupations probably represent brief episodes in the lives of people who spent most of their lives elsewhere in the landscape, but left few if any traces of that activity beyond the cave. For many tropical societies in prehistory, as with many tropical foraging and agricultural societies in the recent past, notions of “permanent home bases” and “stable village settlements” may not be very meaningful (see this volume: Pannell and O’Connor). As the case studies in this volume affirm, the significance of caves for the various human populations who made use of them in antiquity needs exploring on a case-by-case basis, not asserting.

A further difficulty in interpretation relates to the archaeological technologies preserved in caves and rock shelters. The late Pleistocene and early Holocene archaeology of northern latitudes in Eurasia and North America was characterized by extremely complex stone and bone tool technologies, the nature and sophistication of which have frequently been contrasted unfavorably with the “simple” contemporary stone tool assemblages of Southeast Asia. Such a view is misleading because there are instances of quite complex flake-blade industries in Island Southeast Asia (Bellwood 1997) and of prolific lithic assemblages (as, for example, at Bui Ceri Uato; see Veth et al. in this volume). Nevertheless, it remains striking that the total assemblage of stone tools recovered by Tom and Barbara Harrisson in their deep and extensive excavations in the West Mouth of the Great Cave of Niah (Harrisson 1958, 1965, 1970) consisted of a couple of thousand pieces, mostly undifferentiated flakes, contrasting with the hundreds of thousands of pieces, including hundreds of complex retouched blades, that would commonly be found in a Palaeolithic cave deposit in Europe. However, we need to remember

that careful planning was required by foragers in cold-stage northern latitudes to solve their formidable logistical problems. They had to capture, process, and store food given that resources are not only scarce but also available only in certain seasons, with daylight very short in winter, so they generally needed more complex technologies than foragers in richer environments. Woodburn (1980, 1982) termed such foraging strategies, in which food may be stored for months or even years, "delayed return" strategies, contrasting them with the "immediate return" strategies typical of tropical and desert environments. By contrast, the primary purpose of stone technologies for many people living as foragers or farmers in tropical environments must often have been to manufacture equipment of organic materials that has not survived in the archaeological record, or survives only rarely (see this volume: Rabett). Stone tools were frequently tools to make other tools, not tools and weapons per se as in the case of much stone technology in northern latitudes.

THE RAINFOREST FORAGING DEBATE AND PAST GEOGRAPHIES

A particular focus of recent cave archaeology in Island Southeast Asia, within the context of understanding the colonization of the region by modern humans in the late Pleistocene, has been the debate regarding whether prehistoric foragers had the knowledge and technologies to exploit rainforest effectively (Bailey and Headland 1991; Bailey et al. 1989; Brosius 1991; Colvinaux and Bush 1991; Endicott and Bellwood 1991; Headland 1987; Townsend 1990). Certainly it is now clear that, from the outset, prehistoric foragers here practiced effective strategies for exploiting the landscapes they encountered (Anderson 1997; O'Connor et al. 2002a, 2002b; Pasveer 2003; Pavlides and Gosden 1994; this volume: Anderson, Barker, Barton, Leavesley, Paz, Veth et al.). One of the most exciting results of the work at Niah, facilitated by the excellent preservation of organic remains in the sediments, is the evidence for the complexity of foraging behavior from, as far as we can tell, the first use of the cave by modern humans over 45,000 years ago (Barker et al. 2002; this volume: Barker; Barton; Paz), in environments that, while certainly very different from those of today, probably included rainforest (Bird et al. 2004; Kershaw et al. 2001, 2002; and this volume: Gilbertson et al.). Their foraging strategies included hunting a wide range of fauna (Cranbrook 2000), collecting mollusks from local streams, and gathering fruits, nuts, and tuberous forest plants such as aroids, taro, yam, and sago palm, some of the latter category of plant foods requiring considerable know-how to remove toxins to make them edible. The colonization strategies of early foragers in humid tropical environments also seem to have included forest clearance (Groube 1989) and even moving animals and plants from one island to another to enhance food supply (Allen et al. 1989; this volume: Leavesley).

Like the archaeobotanical studies of Barton and Paz, the archaeozoological study by Leavesley affirms the complexity of early foraging strategies, in this case of cuscus (*Phalanger orientalis*) hunting in New Ireland, for the age-profile data indicate a surprising degree of selectiveness in its hunting compared with the hunting behavior of modern rainforest foragers. Selectivity has also been found in the hunting of the Brown Dorcopsis wallaby (*Dorcopsis muelleri*) by Pleistocene foragers using caves in the Bird's Head Peninsula of northwest Papua (Pasveer

2003). The specificity of some foraging technology, like the bone tools that may have been made primarily for exploiting mangrove forest (this volume: Rabett), is another surprise given the traditional assumptions mentioned earlier of Pleistocene and early Holocene foraging technologies in Southeast Asia being “simple” and “general purpose”: the stone tools may often have been, but the organic-material tools they were then used to make were not.

Of course in trying to model past foraging strategies in what are now the humid tropics it is essential to recognize that the landscapes of the late Pleistocene and early Holocene were not like those of today (Bird et al. 2004; Kershaw et al. 2001, 2002; Tapper 2002). The modern situation contrasts in particular with that of the Last Glacial Maximum, which ended at about $19,000 \pm 250$ cal. B.P. (Yokoyama et al. 2000, 2001). The regional palaeogeographical reconstructions of Voris (2000) indicate that, as a result of the glacio-eustatic depression of sea level to about 120 m, peninsular Southeast Asia was joined by land to the present major islands of Sumatra, Java, Borneo, and Palawan to form the “Sundaland” of Molengraaff (1921). Relatively narrow deep-water straits separated Sundaland from both the Philippines and the adjacent maritime continent of “Sahul” (New Guinea and Australia, which were connected by a wide land bridge). Sundaland was approximately twice the area occupied by the present land, with a coastline perhaps only 50 percent of that of today (Dunn and Dunn 1977). Air temperatures were perhaps 6–7°C lower than today and there were significant glaciers on the highest mountains (Peterson et al. 2002), though sea surface temperatures in the South China Sea were perhaps only 2–3°C lower than nowadays. Conditions were generally drier as well as cooler—precipitation is estimated to have been reduced by 30–50 percent on parts of the Sunda Shelf (Kershaw et al. 2001)—but the pattern and extension of reduction varied according to variations in the character of monsoonal circulations (Maxwell and Liu 2002). Sun et al. (2002) concluded, for example, that there was a strengthened winter monsoon that would have led to significant winter precipitation at and inland of north-facing coasts. Biogeographical reconstructions suggest that the altitude of treelines decreased and that dry dipterocarp forest descended to lower levels, with what are currently montane elements present in the lowlands, perhaps producing some plant associations with no modern analogues (Kershaw et al. 2001). Humid lowland tropical rainforest and swamp forests dominated many of the lowlands, especially where winter monsoonal precipitation was strong; a core of lowland rainforest was maintained throughout the LGM despite the reduced warmth and precipitation. The exposed continental-shelf plains also contained estuaries, rivers, lakes, swamps, and lowland rainforest. While biogeographical reconstruction is complicated by pollen taphonomic issues, the total area of lowland rainforest and swamp forest at that time may actually have exceeded in area that of modern times immediately before its widespread clearance. Away from the lowland rainforests, tropical savanna and dry forest extended farther in the region than is presently the case, and steppe vegetation with *Artemisia* or grasslands may have developed with greater latitude and increasing altitude. There may have been a continuous corridor of dry and open savanna vegetation, perhaps 50–150 km wide, located through what is now insular Indonesia and Malaysia, between the South China Sea and the Java Sea (Bird et al. in press).

Following the LGM, across much of the region, temperature and precipitation

increased to achieve a warmth and wetness peak in the Sahul region, at least, at about 9000 years ago (Williams 2002). Ice sheets melted and ocean level rose—at times, very rapidly: a rise of 16 m in only 300 years between 14,600 and 14,300 years ago was estimated by Hanebuth et al. (2000), and 25 m between 14,500 and 14,200 years ago was estimated by Lambeck et al. (2001). Sea levels eventually reached ca. 1–5 m above modern levels by ca. 5000–6000 years ago. The rising sea rapidly engulfed the low-angle continental shelves to produce the modern landscape of peninsulas and myriads of large and small islands, associated, for example, with dramatic shifts in the locations, distributions, and overall extent of mangrove (Grindrod et al. 2002; Woodroffe 2000); yet in some regions similar geographical locations to those flooded elsewhere were uplifted by tectonic action (Ota and Chappell 1999).

These major climatic fluctuations in the late Pleistocene and Holocene clearly had major impacts on landscape and natural biomass production, with significant implications for human colonization opportunities, population size, and subsistence strategies (Bird et al. in press; Godley 2002; Haberle and David 2004). However, to understand the complexity of prehistoric foragers' decision making and responses to landscape change through these millennia, it will be necessary to continue to develop the regional models of climatic and environmental change that are presently available for Southeast Asia for the past 50,000 years, with the aim of achieving robust reconstructions of changing landscape and vegetation configurations at the local scale relevant to the interpretation of archaeological data from individual occupation sites and foraging locales. The complexities of integrating regional palaeoclimatic data sets with a comparatively rich site-based geomorphological record are exemplified in the ongoing work at Niah (this volume: Gilbertson et al.).

TRANSITIONS TO FARMING

The second major "grand narrative" in the prehistory of Peninsular and Island Southeast Asia is the change from foraging to farming. Over the past 20 years, the dominant theory to account for the beginnings of farming here, developed most extensively by Bellwood (e.g., 1985, 1990, 1996, 1997, 2001), has been that of Neolithic colonization. Archaeological and linguistic arguments have led to the formulation of what has been termed the "express train" model: Austronesian-speaking farmers spread southward from mainland China through Island Southeast Asia (settling Taiwan ca. 6000 uncal. B.P. and Borneo ca. 4000 uncal. B.P.) and then eastward across the Pacific, taking a "Neolithic cultural package" with them that included pottery, rice, and domestic pigs and dogs. Alternative theories have also been proposed that posit a long history of animal and plant domestication processes, with new resources and technologies being widely exchanged among Holocene foragers and spreading in complex ways and directions throughout the Pacific region (e.g., Gosden 1995; Latinis 2000; Spriggs 1996; Yen 1995), a model that chimes well with the complex demographic histories that are emerging from genetic studies (Oppenheimer and Richards 2001).

Caves and rock shelters are potentially critical for these debates, because of the long cultural sequences they can provide, associated with food refuse. Most of our botanical data and the most informative faunal samples have been gathered from

recent cave excavations (Pasveer 2003; this volume: Leavesley; Paz). However, as evidenced by virtually all the archaeological case studies in this volume, one of the major trends in Holocene cave use throughout the region, from Neolithic times in the mid Holocene onward, has been the setting aside of many caves as special places for burying the dead (as Gilbertson et al. comment in their paper in this volume, it is possible that the preserving qualities of some guano may have been recognized by past populations). The nature of funerary archaeology inevitably restricts the amount of information available regarding the subsistence lives of people buried with Neolithic pottery, though there are invaluable insights from food offerings, food residues attached to artifacts, plant remains in ceramic fabrics (Doherty et al. 2000), and stable isotope signatures of diet in human skeletons (this volume: Krigbaum). Nevertheless, in every case reported here where Holocene habitation residues have been identified, their study has repeatedly indicated long-lived and variable foraging systems, rather than a sudden commitment to farming associated with the appearance of Neolithic pottery (this volume: Anderson; Barker; Latinis and Stark; Leavesley; Veth et al.). The East Kalimantan cave record (this volume: Chazine) also fits rather poorly with the theory of Austronesian colonization. The study of Holocene forager-farmer transitions in the region clearly needs more well-stratified archaeological sequences with well-preserved food residues (which are most likely to come from cave excavations), as well as further insights from genetic and linguistic models for the population histories of people, animals, and plants. Robust quantitative models are needed on the mechanisms, routeways, and movement capabilities by which humans and key plant and animal taxa could have dispersed and reestablished themselves in the landscapes of Island Southeast Asia in the face of both gradual and sudden local environmental change, whether the latter was naturally and/or humanly induced.

SACRED AND PROFANE

Although the history of cave use in Peninsular and Island Southeast Asia is commonly summarized as a first phase of caves as places of habitation followed by a second phase (Neolithic onward) of caves as places of burial, the studies in this volume affirm that this tendency to interpret deposits as either "domestic" or "funerary" is overly simplistic. The Pleistocene foragers of Niah occasionally buried their dead in the West Mouth, in the "frequentation" zone where they lived and worked (this volume: Barker); this was also the case in the Ban Rai rock shelter in northwest Thailand (this volume: Treerayapiwat). There are "pre-Austronesian" burials amid habitation debris in the caves of central Maluku (this volume: Latinis and Stark) and the Bird's Head of Papua (Pasveer 2003). There may be indications of the structured deposition of damaged bone tools within domestic Pleistocene cultural deposits in a number of Malaysian caves (this volume: Rabett).

Some of the Niah cave entrances were reserved for burial by Neolithic people, but others were used for habitation, and in some places these activities overlapped, though whether Neolithic people here and elsewhere in the region actually camped around where they were burying their dead is unclear (this volume: Anderson; Barker; Chazine). Bird-nesting has been going on for many centuries at Niah, but has respected the ancient cemetery. The same is true of digging

guano: the Holocene guano had been removed for fertilizer from most of the Great Cave long before the archaeological reserve was fenced in, but seems never to have encroached on the Neolithic cemetery (where we estimate there may have been ca. 1000 bodies buried). The degree of planning in the cemetery through its ca. 2500-year life, with what seem to be special areas reserved for children and perhaps separate family plots, has not yet been noted elsewhere in Island Southeast Asia, though there are indications of cemetery planning by the coastal foragers of Khok Phanom Di in central Thailand (Higham and Bannanurag 1990). In southern Thailand in the mid Holocene people used some coastal caves as foci of habitation, adorned others near the sea with paintings, and reserved inland caves for burials (this volume: Anderson). Though the chronological links are uncertain, there are hints that Neolithic communities in east Kalimantan had similar ideas about dividing caves (in this case at different altitudes in limestone cliffs) into separate domains for living, burying, and wall painting (this volume: Chazine). At Niah, cave paintings (mostly of dancing figures and people in boats) were located in direct association with a particular form of burial ("boat burials"), in a cave separate from the main complex, whereas habitation, burials, and paintings were all juxtaposed within the Ban Rai rock shelter (this volume: Treerayapiwat).

CONCLUSION

The caves and rock shelters of Southeast Asia present formidable challenges in terms of the geomorphological and taphonomic processes that have formed and transformed their sediments, processes that in many respects are far less understood than for caves in other environments. At the same time, they are a major archaeological resource: cave excavations in the past have provided the core data for archaeological discussions about the pathways of colonization of Pleistocene and Holocene populations, their lifeways as foragers and farmers, and their belief systems as represented by their burials and cave art, and continue to do so today.

There are no simple trends in cave histories, though. The papers in this volume emphasize above all else the complexity of cave use through time and space. As Latinis and Stark comment in their paper on the caves of central Maluku, combining the evidence of archaeology, ethnography, and history,

Caves have been, and are, used for: temporary (perhaps permanent) habitation; burials; possible ritual locations; processing stations; sources for food, fertilizer, and some highly valued economic commodities; rest stops and temporary shelters; waste disposal; recreation; artists' "canvases" (perhaps even "signal" and "cultural learning" locales); hideouts; military usage; sources or essential parts of folklore; and possible residences of black magic specialists, witches, and so on. . . . It is also likely that a single cave may have experienced several of these different uses simultaneously and/or sequentially.

As they reflect, archaeologists will face significant challenges in establishing reliable archaeological signatures for recognizing many of these activities. One of the most striking features of contemporary/recent cave use here as in East Timor (this volume: Pannell and O'Connor) is the extraordinary paucity of the material culture used by many cave dwellers. The paucity of the archaeology found in many caves probably reflects the fact that many earlier societies in Southeast Asia were characterized by the same kind of "technological economy."

From his excavations of caves in East Timor, Ian Glover (1986) concluded that there was no substantial change in cave use despite significant changes in the life-ways of the people using the caves, specifically the introduction of agriculture ca. 4000–3000 uncal. B.P. He assumed that this must have been because the caves probably represented atypical and biased sets of data, compared with the evidence of central habitation places (as yet undiscovered). The reinvestigations of these sites by Veth et al. reported in this volume have broadly confirmed Glover's arguments for continuity in cave use, but not for reasons of atypicality. "Stable village settlements" were probably not a feature of foraging or farming landscapes here, nor probably indeed elsewhere in most of the region considered in this volume. Rather, they suggest, caves were typical components of larger domestic and totemic landscapes.

Exactly the same point is made from the perspective of present-day cave use by Pannell and O'Connor for the caves of East Timor, where "caves connect people to the wider physical and ideological landscape," from the prehistoric foragers of Lene Hara Cave to the "landscapes of struggle" of East Timor's recent past. The archaeological studies repeatedly emphasize the same linkage between caves and landscapes, how the archaeological remains in the former (bone tools, cave paintings, starch grains, cuscus bones, or whatever) tell us about people's lives in the latter. In short, the most important conclusion of this collection of essays is that caves in Peninsular and Island Southeast Asia were and are integral components of wider physical and cultural landscapes. The variability of human behavior indicated by the archaeology of cave sites is in most cases far more likely to reflect lifeways in the wider world than not. Clearly, caves need to remain at the forefront of archaeological enquiry, though as discussed above there are many challenges to interpretation at every level. To fulfill its potential, cave archaeology in this region requires the elaboration of a solid base of theory and method that in many respects is still underdeveloped.

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REFERENCES CITED

- ALLEN, JIM, CHRIS GOSDEN, AND J. PETER WHITE
1989 Human Pleistocene adaptations in the Tropical Island Pacific: Recent evidence from New Ireland, a greater Australian outlier. *Antiquity* 63:548–561.

ANDERSON, DOUGLAS D.

- 1997 Cave archaeology in Southeast Asia. *Geoarchaeology* 12(6):607–638.

BAILEY, ROGER C., GENEVIEVE HEAD, MARK JENIKE, BRUCE OWEN, ROBERT REICHTMAN, AND ELZBIETA ZECHENTER

- 1989 Hunting and gathering in tropical rainforest: Is it possible? *American Anthropologist* 91:59–82.

BAILEY, ROGER C., AND THOMAS N. HEADLAND

- 1991 The tropical rainforest: Is it a productive environment for human foragers? *Human Ecology* 19(2):261–285.

BARKER, GRAEME, HUW BARTON, PAUL BEAVITT, MICHAEL BIRD, PATRICK DALY, CHRIS DOHERTY, DAVID GILBERTSON, CHRIS HUNT, JOHN KRIGBAUM, HELEN LEWIS, JESSICA MANSER, SUE McLAREN, VICTOR PAZ, PHIL PIPER, BRIAN PYATT, RYAN RABETT, TIM REYNOLDS, MARK STEPHENS, JIM ROSE, GARRY RUSHWORTH, AND MARK STEPHENS

- 2002 Prehistoric foragers and farmers in Southeast Asia: Renewed investigations at Niah Cave, Sarawak. *Proceedings of the Prehistoric Society* 68:147–164.

BELLWOOD, PETER

- 1985 *Prehistory of the Indo-Malaysian Archipelago*. Sydney: Academic Press.
 1990 Foraging towards farming: A decisive transition or a millennial blur? *Review of Archaeology* 11(2):14–24.
 1996 The origins and spread of agriculture in the Indo-Pacific region: Gradualism and diffusion or revolution and colonization? in *The Origins and Spread of Agriculture and Pastoralism in Eurasia*: 465–498, ed. D. R. Harris. London: UCL Press.
 1997 *Prehistory of the Indo-Malaysian Archipelago*, 2nd ed. Honolulu: University of Hawai'i Press.
 2001 Early agriculturalist population diasporas? Farming, languages, and genes. *Annual Review of Anthropology* 30:181–207.

BIRD, MICHAEL, GEOFFREY HOPE, AND DAVID TAYLOR

- 2004 Populating PEP II: The dispersal of humans and agriculture through Austral-Asia and Oceania. *Quaternary International* 118–119:145–163.

BIRD, MICHAEL, COLIN PRENTICE, DAVID TAYLOR, AND CHRIS HUNT.

- In press A savanna corridor in Sundaland? *Quaternary Science Reviews*.

BROSIUS, PETER J.

- 1991 Foraging in tropical rain forests: The case of the Penan of Sarawak, East Malaysia (Borneo). *Human Ecology* 19:123–150.

COLES, GERAINT, AND DAVID GILBERTSON

- 1994 The taphonomy of airfall-pollen in caves: Creswell Crags, England. *Journal of Archaeological Science* 21:735–755.

COLINVAUX, PAUL A., AND MARK B. BUSH

- 1991 The rain-forest ecosystem as a resource for hunting and gathering. *American Anthropologist* 93:153–162.

CRANBROOK, EARL OF

- 2000 Northern Borneo environments of the past 40,000 years: Archaeozoological evidence. *Sarawak Museum Journal* 55:61–109.

DOHERTY, CHRIS, PAUL BEAVITT, AND EDMUND KURUI

- 2000 Recent observations of rice temper in pottery from Niah and other sites in Sarawak, in *Indo-Pacific Prehistory: The Melaka Papers* 4:147–152, ed. P. Bellwood, D. Bowdery, J. Allen, E. Bacus, and G. Summerhayes. Canberra: Australian National University, Bulletin of the Indo-Pacific Prehistory Association.

DUNN, F. L., AND D. F. DUNN

- 1977 Maritime adaptations and the exploitation of marine resources in Sundaic Southeast Asian prehistory. *Modern Quaternary Research in Southeast Asia* 3:1–28.

ENDICOTT, K., AND PETER BELLWOOD

- 1991 The possibility of independent foraging in the rainforest of peninsular Malaysia. *Human Ecology* 19:151–185.

EVERETT, ALFRED H., JOHN EVANS, AND GEORGE BUSK

- 1879– Report on the exploration of the caves of Borneo: And introductory remarks; and a note
 1880 on the bones collected. *Proceedings of the Royal Society of London* 30:310–319.

FOX, ROBERT

- 1970 *The Tabon Caves*. National Museum Monograph 1. Manila: National Museum of the Philippines.

GLOVER, IAN C.

- 1979 The effects of sink action on archaeological deposits in caves: An Indonesian example. *World Archaeology* 10(3):302–317.
- 1986 *Archaeology in Eastern Timor, 1966–67*. Terra Australis 11. Canberra: Australian National University, Research School of Pacific Studies.

GODLEY, DAVID

- 2002 The reconstruction of flood regimes in SE Asia from El Niño–Southern Oscillation (ENSO) related records, in *Bridging Wallace's Line: The Environmental and Cultural Dynamics of the SE-Asian-Australian Region*: 229–254, ed. P. Kershaw, B. David, N. Tapper, D. Penny, and J. Brown. Advances in Geoecology 34. Reiskirchen: Catena Verlag.

GOSDEN, CHRIS

- 1995 Arboriculture and agriculture in coastal Papua New Guinea. *Antiquity* 69:807–817.

GRINDROD, JOHN, PATRICK MOSS, AND SANDER VAN DER KAARS

- 2002 Late Quaternary mangrove pollen records from continental shelf and ocean cores in the northern Australian–Indonesian region, in *Bridging Wallace's Line: The Environmental and Cultural Dynamics of the SE-Asian-Australian Region*: 119–46, ed. P. Kershaw, B. David, N. Tapper, D. Penny, and J. Brown. Advances in Geoecology 34. Reiskirchen: Catena Verlag.

GROUBE, LES

- 1989 The taming of the rainforest: A model for late Pleistocene forest exploitation in New Guinea, in *Foraging and Farming: The Evolution of Plant Exploitation*: 292–317, ed. D. Harris and G. C. Hillman. One World Archaeology 13. London: Unwin Hyman.

HABERLE, SIMON, AND BRUNO DAVID

- 2004 Climates of change: Human dimensions of Holocene environmental change in low latitudes of the PEP-II transect. *Quaternary International* 118–119:165–179.

HANEBUTH, T., K. STATTEGGER, AND P. M. GROOTES

- 2000 Rapid flooding of the Sunda Shelf: A late-glacial sea level record. *Science* 288:1033–1035.

HARRISON, TOM

- 1957 The Great Cave of Niah: A preliminary report on Bornean prehistory. *Man* 57:161–166.
- 1958 The caves of Niah: A history of prehistory. *Sarawak Museum Journal* 8 (n.s. 12):549–595.
- 1959 Radiocarbon datings from Niah: A note. *Sarawak Museum Journal* 9 (n.s. 13–14):136–142.
- 1965 50,000 years of Stone Age culture in Borneo. *Smithsonian Institution Annual Report* 964:521–530.
- 1970 The prehistory of Borneo. *Asian Perspectives* 13:17–45.

HEADLAND, THOMAS N.

- 1987 The wild yam question: How well could independent hunter-gatherers live in a tropical rain forest ecosystem? *Human Ecology* 15:463–491.

HIGHAM, CHARLES F. W., AND RACHANIE BANNANURAG

- 1990 *The Excavation of Khok Phanom Di: A Prehistoric Site in Central Thailand: Vol. 1. The Excavation Chronology and Human Burials*. London: Society of Antiquaries and Thames and Hudson.

HUNT, CHRIS, AND GARRY RUSHWORTH

- In press Pollen taphonomy of airfall sediments in the West Mouth of the Great Cave of Niah, Sarawak. *Journal of Archaeological Science*.

KERSHAW A. PETER, BRUNO DAVID, NIGEL TAPPER, DAN PENNY, AND JONATHAN BROWN, EDS.

- 2002 *Bridging Wallace's Line: The Environmental and Cultural Dynamics of the SE-Asian-Australian Region*. Advances in Geoecology 34. Reiskirchen: Catena Verlag.

KERSHAW, PETER A., DAN PENNY, SANDER VAN DER KAARS, DUSTI ANSHARI, AND ASHA THAMOTHERAMPILLAI

- 2001 Vegetation and climate in lowland southeast Asia at the Last Glacial Maximum, in *Faunal and Floral Migrations and Evolution in SE Asia-Australasia*: 227–236, ed. I. Metcalfe, J.M.B. Smith, M. Morwood, and I. Davidson. Lisse: A. A. Balkema.

LAMBECK, KURT, AND JOHN CHAPPELL

- 2001 Sea level change through the last glacial cycle. *Science* 292:679–686.

LATINIS, D. KYLE

- 2000 The development of subsistence system models for Island Southeast Asia and Near Oceania: The nature and role of arboriculture and arboreal-based economies. *World Archaeology* 32(1):41–67.

LEE, RICHARD B., AND RICHARD DALY

- 1999 Foragers and others, in *The Cambridge Encyclopedia of Hunters and Gatherers*: 1–19, ed. R. B. Lee and R. Daly. Cambridge: Cambridge University Press.

MAXWELL, ANDREW, AND KAM-BIU LIU

- 2002 Late Quaternary Pollen and Associated Records from Monsoonal Areas of Continental South and SE Asia, in *Bridging Wallace's Line: The Environmental and Cultural Dynamics of the SE-Asian-Australian Region*: 189–228, ed. P. Kershaw, B. David, N. Tapper, D. Penny, and J. Brown. *Advances in Geocology* 34. Reiskirchen: Catena Verlag.

MOLENGRAAFF, G.A.F.

- 1921 Modern deep-sea research in the east Indian archipelago. *Geographical Journal* 57:95–121.

O'CONNOR, SUE, KEN APLIN, MATTHEW SPRIGGS, PETER VETH, AND L. AYLIFFE

- 2002a From savannah to rainforest: Changing environments and human occupation at Liang Lemdub, the Aru Islands, Maluku, Indonesia. In *Bridging Wallace's Line: The Environmental and Human History and Dynamics of the Southeast Asian-Australian Region*: 279–306, ed. P. Kershaw, B. David, N. Tapper, D. Penny, and J. Brown. *Advances in Geocology* 34. Reiskirchen: Catena Verlag.

O'CONNOR, SUE, MATTHEW SPRIGGS, AND PETER VETH

- 2002b Excavation at Lene Hara Cave establishes occupation in East Timor at least 30,000–35,000 years ago. *Antiquity* 76:45–50.

OPPENHEIMER, STEPHEN, AND MARTIN RICHARDS

- 2001 Fast trains, slow boats, and the ancestry of the Polynesian islanders. *Science Progress* 84(3):157–181.

OTA, Y., AND J. CHAPPELL

- 1999 Holocene sea-level rise and coral reef growth on a tectonically-rising coast, Huon Peninsula, Papua New Guinea. *Quaternary International* 55:51–59.

PASVEER, JULIETTE

- 2003 *Djief Hunters: 26,000 Years of Lowland Rainforest Exploitation on the Bird's Head of Papua, Indonesia*. Groningen, Rijksuniversiteit Groningen and STIP Stencilwerk Leeuwarden.

PAVLIDES, CHRIS, AND CHRIS GOSDEN

- 1994 35,000-year-old sites in the rainforests of West New Britain, Papua New Guinea. *Antiquity* 68:604–610.

PETERSON, JIM, GEOFF HOPE, MIKE PRENTICE, AND WAYHOW HANTORO

- 2002 Mountain environments in New Guinea and the Last Glacial Maximum 'Warm Seas/Cold Mountains' enigma in the West Pacific Warm Pool Region, in *Bridging Wallace's Line: The Environmental and Cultural Dynamics of the SE-Asian-Australian Region*: 173–188, ed. P. Kershaw, B. David, N. Tapper, D. Penny, and J. Brown. *Advances in Geocology* 34. Reiskirchen: Catena Verlag.

RABY, PETER

- 2001 *Alfred Russel Wallace: A Life*. Princeton, NJ: Princeton University Press.

REYNOLDS, TIM E. G.

- 1993 Problems in the Stone Age of Southeast Asia. *Proceedings of the Prehistoric Society* 59:1–15.

SHERRATT, ANDREW J.

- 2002 Darwin among the archaeologists: The John Evans nexus and the Borneo caves. *Antiquity* 76(291):151–157.

SHIPMAN, PAT

- 2001 *The Man Who Found the Missing Link: The Extraordinary Life of Eugene Dubois*. London: Weidenfeld and Nicholson.

SPRIGGS, MATTHEW

- 1996 Early agriculture and what went before in Island Melanesia: Continuity or intrusion? in *The Origins and Spread of Agriculture and Pastoralism in Eurasia*: 524–537, ed. D. R. Harris. London: UCL Press.

- SUN, X. J., X. LI, AND X. D. CHEN
 2002 The vegetation and climate at the last glaciation on the emerged continental shelf of the South China Sea. *Palaeogeography, Palaeoclimatology, Palaeoecology* 160(3–4):301–316.
- TAPPER, NIGEL
 2002 Climate, climatic variability and atmospheric circulation patterns in the maritime continent region, in *Bridging Wallace's Line: The Environmental and Cultural Dynamics of the SE-Asian-Australian Region*: 5–28, ed. P. Kershaw, B. David, N. Tapper, D. Penny, and J. Brown. *Advances in Geoecology* 34. Reiskirchen: Catena Verlag.
- TOWNSEND, PATRICIA K.
 1990 On the possibility/impossibility of tropical forest hunting and gathering. *American Anthropologist* 92:745–747.
- VORIS, HAROLD K.
 2000 Maps of Pleistocene sea levels in Southeast Asia: Shorelines, river systems and time durations. *Journal of Biogeography* 27:1153–1167.
- WALLACE, ALFRED RUSSEL
 1869 *The Malay Archipelago. The Land of the Orang-Utan and the Bird of Paradise: A Narrative of Travel with Studies of Man and Nature*. 2 vols. London: Macmillan.
- WILLIAMS, MARTIN A. J.
 2002 Quaternary Australia: Extremes in the last glacial-interglacial cycle, in *Billion-Year Earth History of Australia and Neighbours in Gondwanaland*: 55–59, ed. J. J. Veevers. Sydney: GEMOC Press.
- WOODBURN, JAMES
 1980 Hunter-gatherers today and reconstruction of the past, in *Soviet and Western Anthropology*: 95–117, ed. E. Gellner. London: Duckworth.
 1982 Egalitarian societies. *Man* 17:431–451.
- WOODROFE, C. D.
 2000 Deltaic and estuarine environments and their late Quaternary dynamics on the Sunda and Sahul shelves. *Journal of Asian Earth Sciences* 18:393–413.
- YEN, DAVID E.
 1995 The development of Sahul agriculture with Australia as bystander. *Antiquity* 69:831–847.
- YOKOYAMA, Y., KURT LAMBECK, P. DE DEKKER, P. JOHNSTON, AND L. K. FIFELD
 2000 Timing of the Last Glacial Maximum from observed sea-level minima. *Nature* 406:713–716.
 2001 Sea-level at the Last Glacial Maximum: Evidence from northwestern Australia to constrain ice volumes for oxygen isotope stage 2. *Palaeogeography, Palaeoclimatology, Palaeoecology* 165:281–297.

ABSTRACT

This paper introduces the essays in this volume. The challenging complexities of site formation and cave taphonomy in humid tropical environments are emphasized, as is the need for more sophisticated understanding of the geomorphological, biological, and taphonomic processes that affect tropical caves if archaeological remains within them are to be better understood. As the case studies in this collection illustrate, however, tropical cave excavations in peninsular and island Southeast Asia continue to provide new information that is shaping the agenda of discussions about the pathways of colonization of Pleistocene and Holocene human populations, their lifeways as foragers and farmers, and their belief systems as represented by their burials and cave art. The papers also emphasize the complexity of cave use in this region through time and space, but perhaps the most important argument of the volume is that the human use of caves here, past and present, can be understood only as integral components of wider cultural landscapes. **KEYWORDS:** burials, caves, rock shelters, cultural landscapes, farming, foraging, humid tropics, Peninsular Southeast Asia, Island Southeast Asia, taphonomy.